

MEMORY

INTRODUCTION

If you want your PC to perform at its best, it's vital that it has plenty of memory. When Windows runs out of physical RAM, it uses the hard disk as virtual memory, which will slow your PC to a crawl.

If you're upgrading to Windows Vista, you will need more RAM to make applications run smoothly. 1GB is the minimum we recommend, and if you want to run complex applications such as games or video editing, you need at least 2GB.

There are two main types of memory, and we've included both in this month's Labs. DDR RAM is the older, slower type, but there are still plenty of motherboards around that use it. However, most modern PCs use DDR2. We've also included a range of DDR2 memory that's suitable for overclocking, so you can push your PC to its limit. Whether you're building a new PC or upgrading your current one, there's memory here to suit your needs and budget.

Seth Barton

Deputy Reviews Editor



seth@computershopper.co.uk

THANKS FOR THE MEMORY

Upgrading your PC's RAM will make it run faster and smoother. With a 2GB kit costing just £49, adding more memory is an upgrade everyone can afford

Choosing... Memory

It may look confusing at first, but getting the right memory for your PC is actually relatively simple.

Our buying guide will explain how to pick the right memory modules for your needs.

SLOTTING IN

Your first task is to find out whether your motherboard uses DDR or DDR2 memory. It's essential that you buy the correct type of module, as DDR and DDR2 RAM are incompatible with each other. Your motherboard's manual will tell you which type of slots you have.

If you don't have a copy of your motherboard manual, you can use a tool called CPU-Z from www.cpubid.com/cpuz.php. This will tell you the name of your motherboard, as well as the type of memory installed, its size, and which modules are in which slots.

A PERFECT MATCH

All the memory we've tested comes in matched pairs of modules, called kits, so you'll need two spare slots. Modern motherboards have a dual-channel memory bus, so using pairs of memory gives you a performance advantage over using single sticks of the same size.

We've included both 1GB kits (two 512MB modules) and 2GB kits (two 1GB modules) in the group.

A 1GB kit will be enough for everyday tasks such as browsing the net or using office applications. If you plan to take on tougher tasks, such as photo or video editing, we'd strongly recommend a 2GB kit.

RAMMING SPEED

CPU-Z's memory tab will report the speed at which your current memory runs. However, this figure will be half that of the RAM's effective clock speed, as both DDR and DDR2 can transfer data twice per cycle and, in effect, double their bandwidth. This is why they are called double data rate (DDR) modules.

To confuse matters further, there are two ways of describing memory speed. The simplest is to list the speed in MHz, taking into account the double data rate, which is usually 400MHz for DDR and 800MHz for DDR2. Manufacturers also list the maximum transfer rate in megabytes, which is eight times higher than the MHz figure. For this reason you'll also see names such as PC 3200 or PC2 6400.

DDR and DDR2 memory is available in a wide variety of speeds. DDR runs at speeds of up to 400MHz, also known as PC 3200, while most DDR2 memory can run at up to 800MHz, or PC2 6400. Bear in mind that these speeds are the modules' maximum rated speeds,



and the memory will run fine at any speed up to the maximum. For this reason, even though your motherboard may not support a memory module's maximum speed, the module will still work fine at the motherboard's lower speed. Some memory manufacturers have memory advisor tools on their websites, which will tell you which type of module is compatible with your PC.

Different RAM kits with the same speed rating can also have different latency timings. Latency is the delay between the processor requesting information from the memory and the memory providing it. Lower latencies generally make for better performance.

Most memory modules use the JEDEC standard for latencies, and these are the timings that most motherboards will detect and use. Some modules also have EPP timings. These are used by motherboards with nVidia 590 or 690 chipsets. If you have one of these motherboards, it should set the memory to use the EPP timings, which can be lower than the JEDEC timings. In our tests we set each motherboard to use the more common JEDEC timings.

TAKE IT TO THE LIMIT

If you want to overclock your PC you should be aware that DDR2 memory is also available at higher-rated speeds, including PC2 8500 and PC2 9200. These modules are designed to run

How we test Memory

To test DDR memory we used an Athlon 64 4200+ in an ECS KN1 Extreme motherboard. For DDR2 memory, where overclocking is arguably more important, we wanted to make sure that the processor wasn't a limiting factor, while keeping our benchmark results comparable to our reference 1.86GHz Core 2 Duo E6300 system. To do this, we fitted an ASUS Blitz Formula motherboard with a Core 2 Duo E6750. We then dropped the frontside bus speed from 1,333MHz to 1,066MHz and changed the multiplier from 8x to 7x. This meant the processor was running at the same speed as the Core 2 Duo E6300, but left us with plenty of room for overclocking.

For both DDR and DDR2 we then slowly increased the motherboard's frontside bus, running our multitasking benchmark to check stability. The last stable score and percentage overclock is recorded in the table.

faster than the more common PC2 6400 memory. Overclocking your PC can increase its performance, but you'll need a motherboard with the correct controls in the BIOS to do this. An overclocked PC may produce more heat, so make sure it has adequate cooling.

This month

Standard DDR RAM

KINGSTON
KVR400X64C3AK2/1G
Page 112



CRUCIAL
CT2KIT6464Z40B
Page 112



KINGSTON
KVR400X64C3AK2/2G
Page 112



CRUCIAL
CT2KIT12864Z40B
Page 112



Standard DDR2 RAM

KINGSTON
KVR800D2N5K2/1G
Page 113



CRUCIAL
CT2KIT6464AA80E
Page 113



KINGSTON
KVR800D2N5K2/2G
Page 113



CRUCIAL
CT2KIT12864AA80E
Page 113



Overclocking DDR2 RAM

TEAM
TEDD1024M800HC5DC
Page 113



CORSAIR
TWIN2X2048-6400
Page 113



G.SKILL
F2-6400CL4D-2GBPK
Page 112



A-DATA
ADQVD1A16x2
Page 112



CORSAIR
TWIN2X2048-6400C4DHX
Page 112



CRUCIAL
BL2KIT12864AA804
Page 112



TEAM
TXDD2048M800HC4DC
Page 112



KINGSTON
KHX8500D2K2/2G
Page 113



CELL SHOCK
CS2221041
Page 113



OCZ
OCZ2FX11502GK
Page 113



STANDARD DDR RAM

STANDARD DDR2 RAM

MANUFACTURER	KINGSTON	CRUCIAL	KINGSTON	CRUCIAL	KINGSTON
Model	KVR400X64C3AK2/1G	CT2KIT6464Z40B	KVR400X64C3AK2/2G	CT2KIT12864Z40B	KVR800D2N5K2/1G
Rating	★★★★	★★★	★★★	★★★★	★★★
FEATURES					
Module size	512MB	512MB	1,024MB	1,024MB	512MB
Number of modules	2	2	2	2	2
Total amount of memory	1,024MB	1,024MB	2,048MB	2,048MB	1,024MB
Rated speed	400MHz	400MHz	400MHz	400MHz	800MHz
Rated bandwidth	PC 3200	PC 3200	PC 3200	PC 3200	PC2 6400
Latencies at this speed	3-3-3-8	3-3-3-8	3-3-3-8	3-3-3-8	5-5-5-18
Heatspreader	No	No	No	No	No
OVERCLOCKING RESULTS					
Maximum FSB	230MHz	230MHz	230MHz	230MHz	306MHz
Maximum module speed	460MHz	460MHz	460MHz	460MHz	918MHz
Multitasking test (overclocked)	163	167	178	173	174
Overclock	15%	15%	15%	15%	15%
BUYING INFORMATION					
Price inc VAT	£35	£38	£68	£70	£29
Supplier	www.ebuyer.com	www.crucial.com/uk	www.ebuyer.com	www.crucial.com/uk	www.dabs.com
Details	www.kingston.com	www.crucial.com	www.kingston.com	www.crucial.com	www.kingston.com
Part code	KVR400X64C3AK2/1G	CT2KIT6464Z40B	KVR400X64C3AK2/2G	CT2KIT12864Z40B	KVR800D2N5K2/1G
REVIEW					

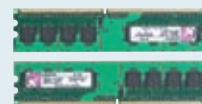
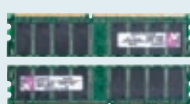
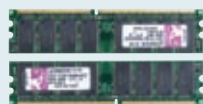
This 1GB kit is the cheapest DDR memory in the group at only £35 including VAT. Performance was good, and it achieved slightly higher scores in our image and multitasking benchmarks than Crucial's 1GB DDR kit. The kit costs half as much as Kingston's 2GB DDR kit, so if you just want to do basic tasks on your PC, it's a fine choice.

There's very little to distinguish this kit from Kingston's 1GB DDR kit. They both have the same timings and both overclock to a maximum of 460MHz. This kit was a touch slower in our image and multitasking benchmarks and costs £3 more than the Kingston memory, so it doesn't offer quite such good value.

Kingston's 2GB DDR kit is twice the price of its 1GB kit, so you don't get any added value by buying higher-capacity modules. If you work with video or photo files on a Windows Vista PC, it's worth paying the extra. This kit wasn't quite as quick in our image and multitasking benchmarks as Crucial's 2GB DDR kit, so the Crucial kit is a better buy.

Crucial's 2GB DDR kit is almost identical to the equivalent kit from Kingston. They both have the same memory timings and can be overclocked to 460MHz. However, the Crucial kit was slightly quicker in our image and multitasking benchmarks and is only slightly more expensive, making it the best 2GB DDR kit in the group.

This is the cheapest 1GB DDR2 kit in the group. Like all the standard DDR2 memory it has fairly loose 5-5-5-18 timings. It performed acceptably in our benchmarks with an overall score of 152. We managed to overclock it by 15 per cent to a maximum module speed of 918MHz. Team's 1GB overclocking kit costs just £4 more, though, and overclocks further.



MANUFACTURER	G.SKILL	A-DATA	CORSAIR	CRUCIAL	TEAM
Model	F2-6400CL4D-2GBPK	ADQVD1A16x2	TWIN2X2048-6400C4DHX	BL2KIT12864AA804	TXDD2048M800 HC4DC
Rating	★★★	★★★	★★★	★★★★★	★★★
FEATURES					
Module size	1,024MB	1,024MB	1,024MB	1,024MB	1,024MB
Number of modules	2	2	2	2	2
Total amount of memory	2,048MB	2,048MB	2,048MB	2,048MB	2,048MB
Rated speed	800MHz	800MHz	800MHz	800MHz	800MHz
Rated bandwidth	PC2 6400	PC2 6400	PC2 6400	PC2 6400	PC2 6400
Latencies at this speed	5-5-5-15	5-5-5-18	5-5-5-18	5-5-5-18	5-5-5-18
Heatspreader	Yes	Yes	Yes	Yes	Yes
OVERCLOCKING RESULTS					
Maximum FSB	306MHz	300MHz	306MHz	412MHz	359MHz
Maximum module speed	918MHz	900MHz	918MHz	1,237MHz	1,077MHz
Multitasking test (overclocked)	186	179	183	257	218
Overclock	15%	10%	15%	55%	35%
BUYING INFORMATION					
Price	£55	£57	£67	£73	£78
Supplier	www.memoryc.com	www.memoryc.com	www.scan.co.uk	www.crucial.com/uk	www.memoryc.com
Details	www.gskill.com	www.adata.com.tw	www.corsair.com	www.crucial.com	www.teamgroup.com.tw
Part code	F2-6400CL4D-2GBPK	ADQVD1A16X2	TWIN2X2048-6400C4DHX	BL2KIT12864AA804	TXDD2048M800HC4DC
REVIEW					

The G.Skill memory's bright blue heatspreaders look great, and the modules did well in our image-manipulation, multitasking and Call of Duty 2 tests. However, we could overclock them by only 15 per cent, giving them a maximum module speed of 918MHz. G.Skill claims these modules have timings of 4-4-4-12, but the JEDEC timings are actually a looser 5-5-5-15. The price is reasonable, but there's better and cheaper memory in the group.

This memory looked impressive at first, with strong scores in our audio and video benchmarks. As with much of the overclocking memory, the manufacturer claims tighter timings than the actual JEDEC standards we use to run our tests. In testing we could overclock it by only up to 10 per cent before the PC became unstable. Even if you plan to run the modules at the standard speed, you're better off saving some money and getting Corsair's TWIN2X2048-6400 2GB DDR2 kit.

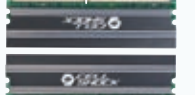
This kit has some of the most impressive heatspreaders we've ever seen. They make each module about twice as big as normal. The kit put in a decent performance in our benchmarks, but we could overclock it by only 15 per cent before it became unstable. The price is reasonable at £67 including VAT, but if you're not worried about serious overclocking, Corsair's cheaper TWIN2X2048-6400 kit is a better buy.

If you're serious about overclocking your PC and you want some memory that's up to the job, this kit from Crucial is ideal. We had it running stably at 55 per cent faster than its rated speed. Only OCZ's kit could go as high, and that costs twice as much. The RAM also gained consistently good benchmark scores. If you want to push your PC as far as you can, this is the overclocking RAM to get. It's a Best Buy.

This 2GB kit was a touch slower than most of the overclocking DDR2 in our benchmarks. The manufacturer claims tight timings of 4-4-4-10, but these are based on the EPP standard, rather than the more widely accepted JEDEC timings of 5-5-5-18. We managed to push the modules up to 1,077MHz before they became unstable, which is a reasonable overclock of 35 per cent. Crucial's BL2KIT12864AA804 is cheaper and more overclockable, though.



OVERCLOCKING DDR2 RAM					BUDGET BUY
CRUCIAL	KINGSTON	CRUCIAL	TEAM	CORSAIR	
CT2KIT6464AA80E	KVR800D2N5K2/2G	CT2KIT12864AA80E	TEDD1024M800HC5DC	TWIN2X2048-6400	
★★★★	★★★	★★★★★	★★★★★	★★★★★	
512MB	1,024MB	1,024MB	512MB	1,024MB	
2	2	2	2	2	
1,024MB	2,048MB	2,048MB	1,024MB	2,048MB	
800MHz	800MHz	800MHz	800MHz	800MHz	
PC2 6400	PC2 6400	PC2 6400	PC2 6400	PC2 6400	
5-5-5-18	5-5-5-18	5-5-5-18	5-5-5-15	5-5-5-18	
No	No	No	Yes	Yes	
346MHz	313MHz	379MHz	346MHz	333MHz	
1,037MHz	929MHz	1,137MHz	1,037MHz	1,000MHz	
212	191	238	193	189	
30%	17.5%	42.5%	30%	25%	
£35	£60	£63	£33	£49	
www.crucial.com/uk	www.morecomputers.co.uk	www.crucial.com/uk	www.memoryc.com	www.scan.co.uk	
www.crucial.com	www.kingston.com	www.crucial.com	www.teamgroup.com.tw	www.corsair.com	
CT2KIT6464AA80E	KVR800D2N5K2/2G	CT2KIT12864AA80E	TEDD1024M800HC5DC	TWIN2X2048-6400	
Crucial's 1GB DDR2 kit achieved the same overall score in our application benchmarks as Kingston's 1GB standard DDR2 kit, but is more overclockable. We overclocked the Crucial kit by an impressive 30 per cent on our test PC, which is more than many of the overclocking DDR2 kits. It's a couple of pounds more expensive than Team's 1GB kit, though, which also overclocks up to 1,037MHz and has stylish heatspreaders.	If you've recently upgraded to Windows Vista, having 2GB of memory will make your system run far more smoothly. This 2GB DDR2 kit from Kingston can be overclocked by 17.5 per cent up to 929MHz. It performed well in all the <i>Shopper</i> benchmarks with an overall score of 156. However, Corsair's TWIN2X2048-6400 kit has similar performance, can be overclocked further and costs £11 less.	This 2GB kit was impressive in our overclocking tests. We managed to push our test PC to a front-side bus speed of 379MHz, with the modules running at an incredible 1,137MHz, and all without any kind of heatspreader. The kit also achieved consistently high scores in our benchmarks, and one of the joint top three scores overall. It's a fast and overclockable 2GB DDR2 kit at a good price.	Just because a memory module has heatspreaders, it doesn't necessarily mean it's expensive. Team's 1GB DDR2 kit is the second-cheapest in the test. It's as overclockable as Crucial's 1GB standard DDR2 kit, and is faster than Kingston's 1GB standard DDR2 kit. It's also £2 less than the Crucial kit, making it the best 1GB DDR2 kit in the group.	This 2GB kit would look good in most gaming PCs. It did well in our benchmarks with an overall score of 156. You can also overclock it up to 25 per cent, which is respectable if not outstanding. It's remarkably inexpensive at just £49, which makes it the cheapest 2GB kit in the group. It's not the best kit in the group for overclocking, but it's excellent value for a 2GB DDR2 memory kit.	
					

KINGSTON	CELL SHOCK	OCZ
KHX8500D2K2/2G	CS2221041	OCZ2FX11502GK
★★	★★★★	★★★
1,024MB	1,024MB	1,024MB
2	2	2
2,048MB	2,048MB	2,048MB
1,066MHz	800MHz	1,150MHz
PC2 8500	PC2 6400	PC2 9200
5-5-5-16	5-5-5-18	5-5-5-15
Yes	Yes	Yes
333MHz	399MHz	412MHz
1,000MHz	1,197MHz	1,237MHz
198	249	246
-6% (wouldn't run at 1,066MHz)	50%	7.5%
£79	£96	£150
www.mediaatlantic.com	www.memoryc.com	www.ebuyer.com
www.kingston.com	www.cellshock.msc.de	www.ocztechnology.com
KHX8500D2K2/2G	CS2221041	OCZ2FX11502GK
Kingston's 2GB overclocking DDR2 kit is one of only two kits in the group that are rated to run above the usual 800MHz speed. The modules' PC2 8500 rating means they should run at 1,066MHz. However, we couldn't get them to run stably on our test PC at anything above 1,000MHz. This is 66MHz slower than the modules' rated speed, which equates to a 6 per cent underclock. These modules are expensive and can't run at their rated speed, so are poor value.	Rather than fitting flashy heatspreaders as many of the manufacturers in the overclocking group have, German memory manufacturer Cell Shock has opted for business-like matt-black heatspreaders. This is an impressive kit, as we managed to overclock the memory by a huge 50 per cent until the modules were running at 1,197MHz. It's much more expensive than Crucial's 2GB overclocking kit, though, which also overclocks further than the Cell Shock modules.	This pair of modules from OCZ is designed to be compatible with water-cooling systems. Fortunately the heat spreaders can also dissipate excess heat into the air. The modules are rated at PC2 9200, so they should be able to work up to 1,150MHz. The kit exceeded even this high target, running at a top speed of 1,237MHz. However, you can get similar performance from Crucial's BL2KIT12864AA804 kit for less than half the price.
		

Labs verdict Memory

We were surprised by the low prices of some of the overclocking memory in this month's Labs, and also by the overclocking ability of some of the standard memory modules. In the end, five kits stood out, which should cover almost any memory requirement.

If you need DDR memory, there's very little difference between the modules from competing manufacturers. If you want a 1GB kit you're better off with Kingston's cheaper modules, while Crucial's 2GB kit is faster than Kingston's equivalent and a better choice if you need the extra capacity.

If you're short of cash but need to buy DDR2 memory, Team's TEDD1024M800HC5DC 1GB kit is very cheap and can even be overclocked by up to 30 per cent. However, if you're currently running Windows Vista or are planning to upgrade from Windows XP, we'd highly recommend spending another £16 on Corsair's TWIN2X2048-6400 2GB kit. It's cheap, fast and can be overclocked by up to 25 per cent. It's our Budget Buy winner.

You don't have to spend a fortune to get the best possible overclocking performance. Crucial's BL2KIT12864AA804 2GB DDR2 kit costs just £73 yet can be overclocked by an incredible 55 per cent, all without particularly fancy heatspreaders. It's excellent value, and wins our Best Buy award.

**CORSAIR**
TWIN2X2048-6400

**CRUCIAL**
BL2KIT12864AA804

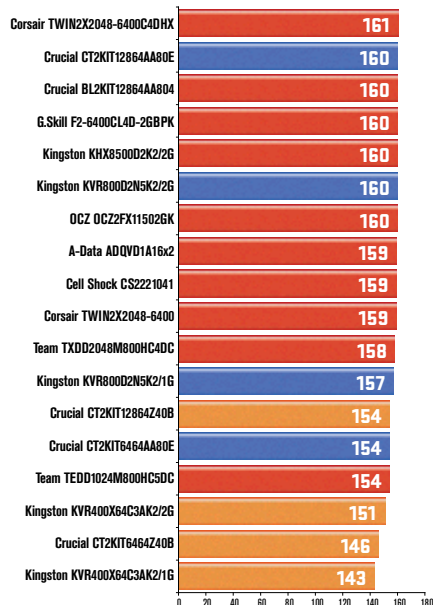
BENCHMARKS

Standard
DDR RAMStandard
DDR2 RAMOverclocking
DDR2 RAM

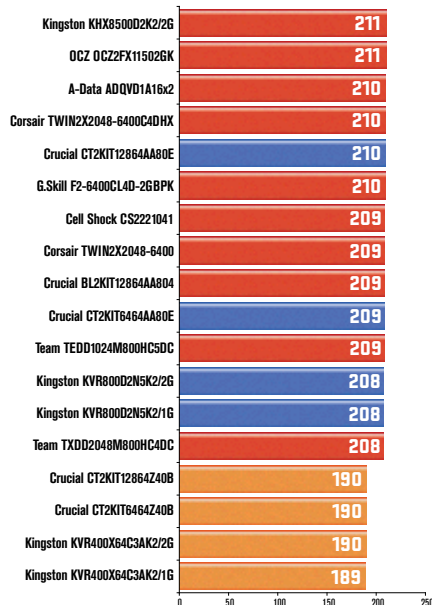
All scores are without overclocking. For overclocked performance, see the tables on pages 112 and 113.

2D Performance Shopper application tests

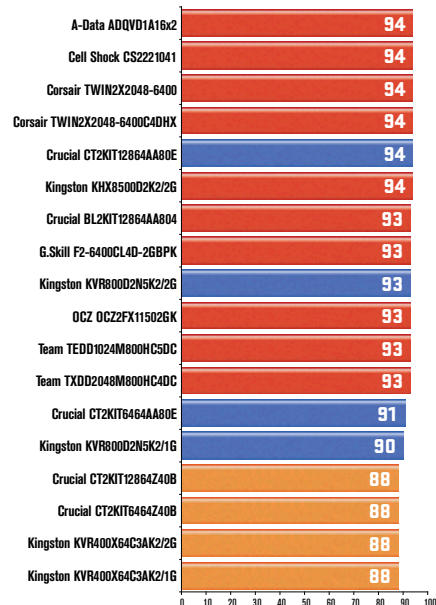
Image-Editing



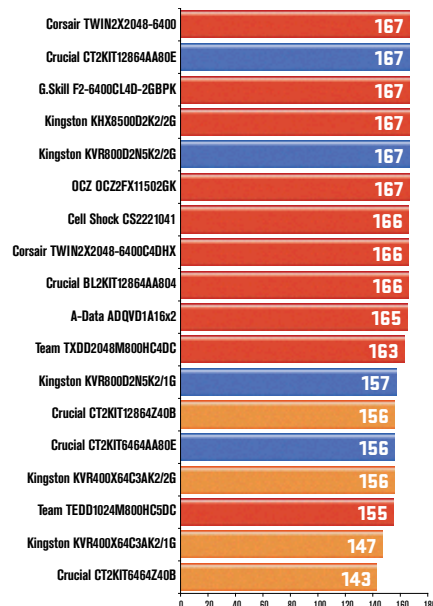
Video-Encoding



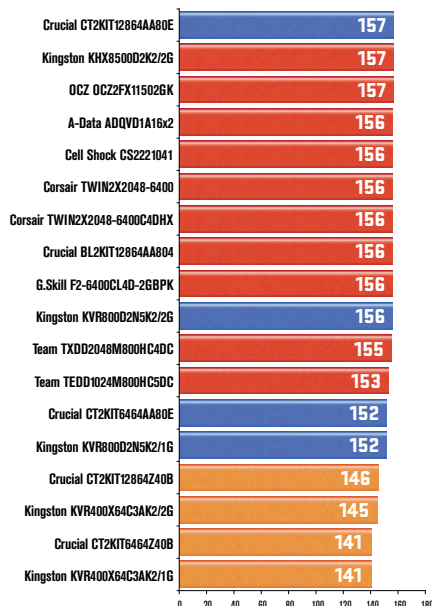
Audio



Multitasking



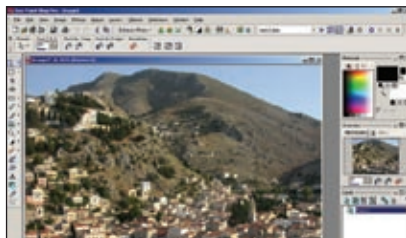
Overall



Computer Shopper's 2D benchmarks have been designed to show how PCs stand up to the toughest tasks Windows can throw at them. Today's PCs have no problem running office applications such as Word and Excel, so we have chosen to focus our tests on areas where you could experience difficulties.

Encoding a short video to MPEG2 format is a processor-intensive task that anyone transferring home videos to DVD will have to tackle. Our image-editing test simulates a session of photo enhancement using Paint Shop Pro X. In our third test, a set of audio files is ripped to MP3 format.

Finally, we have a multitasking test designed to test the benefits of HyperThreaded and dual-core processors. This test compresses

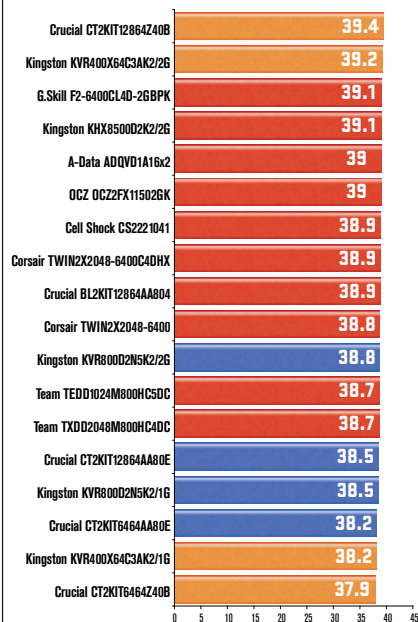


SETTINGS We run our application tests at 1,280x1,024 resolution and in 32-bit colour
WEB www.computershopper.co.uk

a DVD at the same time as running our image-editing test. Figures are relative to a reference Evesham Athlon 64 3500+, which scores 100 in all tests.

3D Performance Games

Call of Duty 2 (fps)



SETTINGS 1,280x1,024 resolution, 32-bit colour, default settings
WEB www.futuremark.com

Call of Duty 2 uses DirectX and is one of the most demanding games available. With a wide range of effects and frenetic action, it tests every aspect of graphics performance. The results of this test show how well memory will cope with the latest games coming on to the market at the moment **CS**